A New Species of *Chelidonura* from Bahía San Carlos, Gulf of California, with a Synonymy of the Family Aglajidae

BY

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(1 Map; 8 Text figures)

INTRODUCTION

ONLY ONE SPECIES in the genus *Chelidonura,* an opisthobranch gastropod of the order Cephalaspidea, has been known in the Gulf of California; *C. inermis* (Cooper, 1862) occurs in much of Southern California as well as on the Mexican coast.

On December 22 and 25, 1969, the authors together with Scott Williams and Michael Gosliner of Marin County, California, collected 3 specimens of an unknown species of *Chelidonura* from the intertidal mud flats of San Carlos Bay, Sonora, Mexico. On December 24, 1970, 7 additional specimens were collected from the same area. Later investigation showed the animal to be an undescribed species. The drawings presented are by Gary C. Williams.

Chelidonura polyalphos Gosliner & Williams, spec. nov.

Diagnosis: Straight, shortened, reduced esophagus; position of the buccal ganglia adjacent to the pharyngo-esophageal juncture; elongated thread-like salivary glands; abrupt pharynx; easily identifiable pharyngo-esophageal juncture; small, flattened bursa copulatrix; receptaculum seminis near coelomic gonoduct; smooth, unarmed penial bulb; black body uniformly white-spotted; small, uniform size (under 40 mm in length); shell length to shell height ratio about 2 : 1.

Type Material: The holotype specimen, on which preliminary dissections were carried out, has been deposited at the California Academy of Sciences, San Francisco, California in the Invertebrate Zoology Type Collection, where it bears the number CASIZ 549. Several paratypes on which the bulk of the dissections were done are in our private collections.

Name: The name *polyalphos* is derived from the Greek πολμς (= many) and αλφος (meaning a white spot on the skin). The "many white spots," however minute, and covering the external surface of the animal, are the most striking feature to one observing the living animal for the first time.

Taxonomic Position in the subclass Opisthobranchiata:

CEPHALASPIDEA

AGLAJIDAE

Chelidonura

polyalphos

WORLD SPECIES LIST

The following is a list of species names currently in use in the genus *Chelidonura* A. Adams, 1850:

Chelidonura adamsi Angas, 1867
C. africana Pruvot-Fol, 1953
C. amoena Bergh, 1905
C. conformata Burn, 1966
C. evelinae Marcus, 1955
C. fulvipunctata Baba, 1938
C. hirundinina (Quoy & Gaimard, 1832)
C. inermis (Cooper, 1862)
C. inornata Baba, 1949
C. mediterranea Swennen, 1961
C. nyanyana Edmunds, 1968

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C. obscura (Bergh, 1902)
C. pallida Risbec, 1951
C. perparva (Risbec, 1928)
C. philinopsis Eliot, 1903
C. plebeia Bergh, 1900
C. polyalphos Gosliner & Williams, 1972
C. sanguinea (Allan, 1933)
C. tsurugensis Baba & Abe, 1959
C. varians Eliot, 1903
C. velutina Bergh, 1905

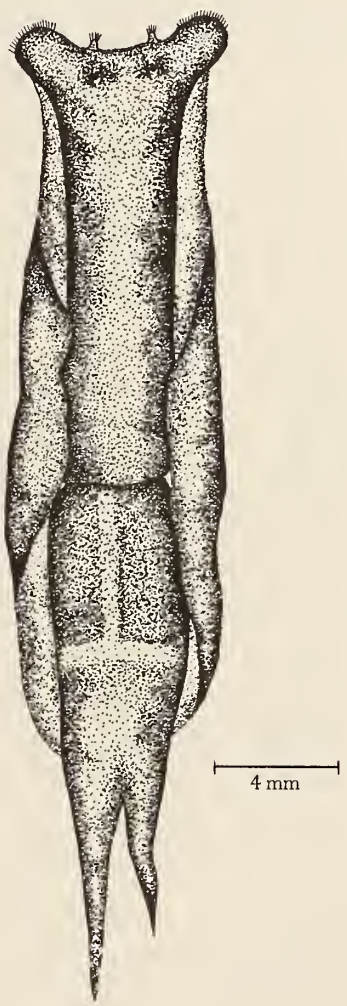


Figure 1

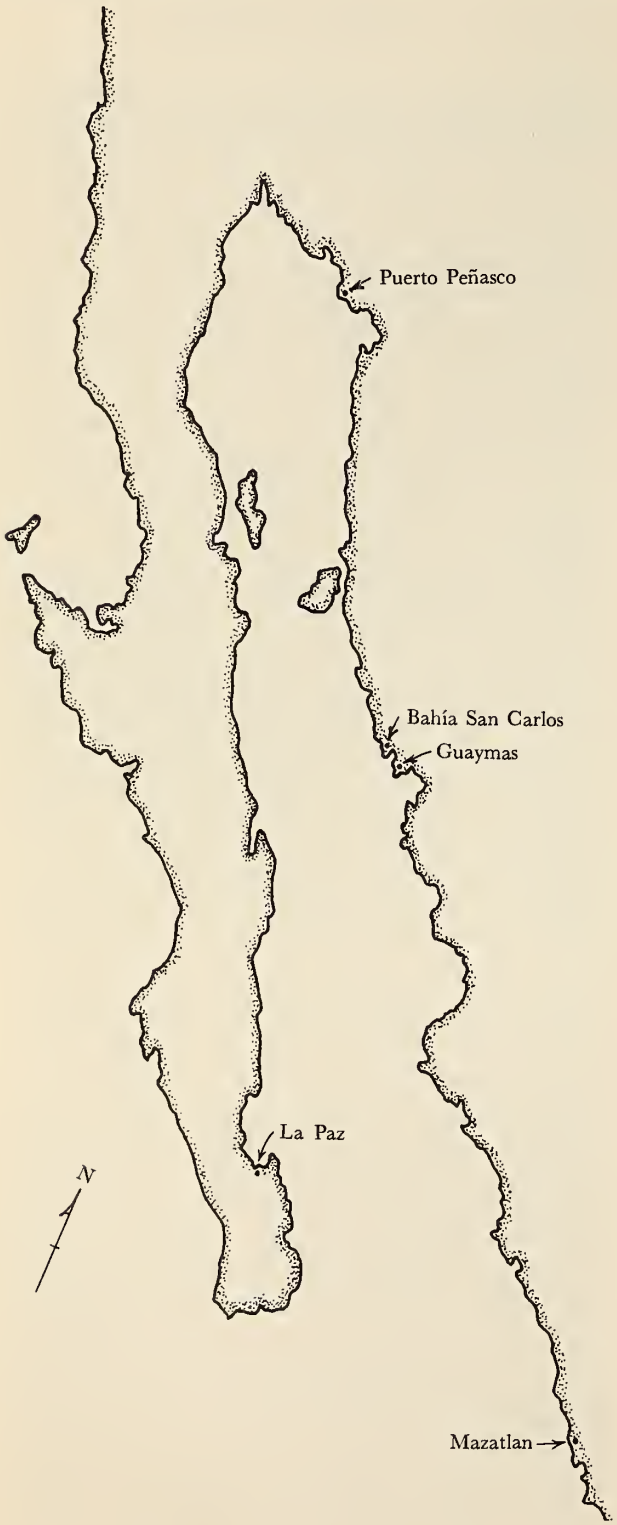
Chelidonura ***polyalphos*** Gosliner & Williams, spec. nov. dorsal aspect

NATURAL HISTORY

Type Locality: The type locality of *Chelidonura* ***polyalphos*** is Bahía San Carlos, 6 km north of Guaymas, Sonora, Mexico (Lat. 27°55′ N; Long. 111°05′ W). The region of San Carlos Bay is extremely variable topographically and includes many differing environments. On both sides of the mouth of the bay are found volcanic rock reefs which are quite rugged. Immediately inside of the mouth of the bay and extending along most of the inner shore are areas containing many rocks and providing suitable shelter for a variety of animals. Along the north shore of the bay, opposite the mouth, runs a sandy spit. To the far north of this spit is a mangrove swamp, and to the south there are extensive mudflats. It is these mudflats that are of interest at present since they represent the only location where *Chelidonura* ***polyalphos*** has been collected.

Wave action inside the bay is minimal and tidal action allows a substantial portion of the mudflats (approximately 20 000 m²) to be exposed twice daily. At high tide, the water depth covering the mudflats does not exceed 90 cm. Daytime water temperature varies from about 32° C to 15° C from September to December. Daytime air temperature varies from 43° C to 18° C during the same period. It is not known how these seasonal temperature variations affect the population of *Chelidonura* ***polyalphos,*** since observations were carried out only during the month of December 1969 and 1970.

Habitat: *Chelidonura* ***polyalphos*** has been found exclusively on the mudflats of Bahía San Carlos. It has been seen crawling in the small intertidal pools, generally less than 2 m in diameter, which contain the algae *Spirodea filamentosa* and *Enteromorpha* sp. The depth of these pools does not exceed 15 cm at low tide. *Haminoea virescens* (Sowerby, 1833) commonly occurs also in this community as does *C. inermis,* which, however, is much less abundant. Although dives were made inside the bay down to 3 m, no specimens were observed subtidally. The substrate is light gray in color and composed of very fine silty mud that has a clean sandy texture. It would seem that the main contributions of nitrogenous material cycling in this subtropical marine ecosystem come from a combination of bird guano and various invertebrates and fish that wash ashore. Several large, decaying fish (primarily trigger fish, *Balistes* sp.) have been observed on the mud surface, often half buried. Many bivalve and prosobranch shells can also be found in the same situation. Several species of sea birds come to feed, usually in great numbers, on these mud flats at low tide.



Map of the Gulf of California

Locomotion: In a glass aquarium of 15-gallon capacity, at 16.5° C, a 3.7 cm long specimen of *Chelidonura polyalphos* crawled on the side wall at a rate of between 6 and 6.5 cm per minute. On flat rock surfaces, the specimen crawled at the same rate. No observations were made of the animal crawling on its natural substrate. Locomotion is accomplished by rapid pedal waves. As the animal proceeds forward, the body is kept uniform in shape and size. Often, however, the animal may extend the parapodia downward while crawling.

Feeding: No observations were made on the animal while feeding. However, animals kept in 1-gallon capacity containers and isolated from other species, egested shells of *Haminoea virescens*. This was observed on 2 occasions; the egested shells did not exceed 5 mm in length.

MORPHOLOGY AND ANATOMY

External Characteristics: The ground color of the animal is a very dark brown, often appearing black; it is decorated with numerous small white spots, not exceeding ½ mm in diameter, which become larger and more numerous in certain areas along the dorsal surface, giving a patched appearance. The distribution of white patching is not consistent throughout the animals found, although patches were observed on each individual. Often, these patches may appear as T-shaped bars or straight bars across the shields. The animal, when in sunlight, appears to have a bluish iridescent sheen on the external surface of the contracted parapods. On the inside of the parapods is a greenish tint which gradually blends into the normal ground color of the body. Faint, minute green spots forming a V-shape on the inside ventral surface of the caudal lobes were noted in several specimens.

The general shape of the animal is typical of the members of the genus *Chelidonura;* it is particularly similar to *C. evelinae* and *C. inermis*. The posterior folds of the caudal lobes extend behind the animal. The right and left lobes are quite variable with respect to size. In some individuals the left lobe was longer, in others the right lobe was longer; in one individual both lobes were of equal length. The animal, when actively crawling, has the parapodia folded tightly around the latero-dorsal surface. The organism tends to open the parapodia when exposed to strong light, particularly noticeable when it was being photographed in direct sunlight. At the front of the head, just above the mouth, are 2 small projections, found in several species of the genus, and covered with chemosensory setae. The setae are also found in *C. evelinae* and *C. inermis,* as are setae on the sides of the anterior portion of the cephalic lobes. The cephalic shield covers the anterior and pharyngeal region of the animal, and gives way ab-

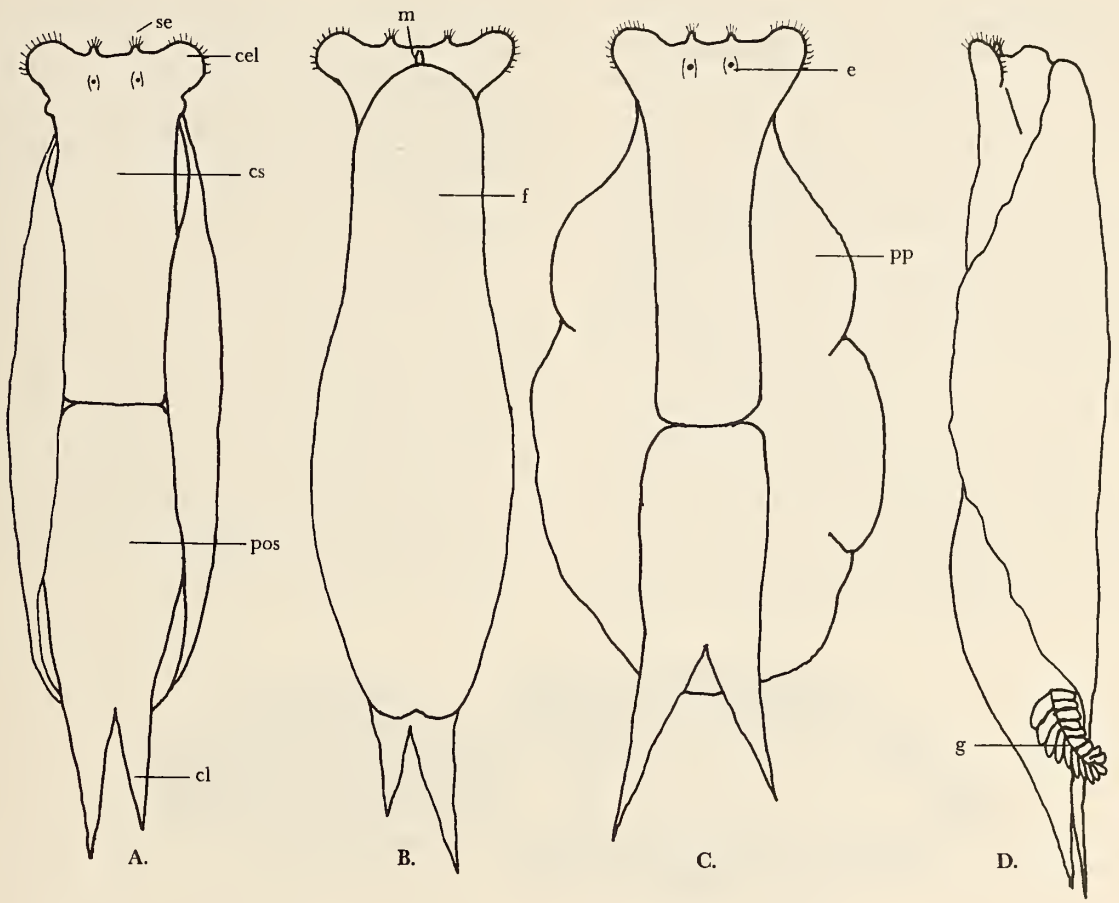


Figure 2

Chelidonura polyalphos Gosliner & Williams, spec. nov.

Diagram of external features
A. Dorsal view; B. Ventral view; C. Dorsal view with parapodia extended; D. Right lateral view

cel – cephalic lobe; cl – caudal lobe; cs – cephalic shield; e – eye; f – foot; g – gill; m – mouth; pos – posterior shield (visceral shield); pp – parapod; se – setae

ruptly to the posterior or visceral shield which covers the mantle and posterior viscera.

Collected specimens ranged in size from 20 to 37 mm in length and 5 to 9 mm in width. No specimens observed at the type locality exceeded 40 mm. The holotype, when actively crawling, measured 32 mm in length.

Shell: The shell of *Chelidonura polyalphos* is much reduced as in other members of the family Aglajidae and contains a large rib-like structure emanating from the central whorl. The rib is thickened on the inside of the shell, which lies across the anal tube and adjacent to the digestive gland. The shell color is generally yellowish-brown, becoming lighter in the thinner regions. The shell, viewed dorsally, follows a slight clockwise curvature to the right side of the anal region. The shell of the holotype measures $3\frac{1}{2}$ mm in length and has a maximum height of 1.8 mm.

Digestive System: The digestive system of *Chelidonura polyalphos* is the most massive organ system in the animal and is composed of 3 basic regions which, when taken together, produce the bulky appearance of the animal's

body. These 3 regions are the pharynx, the esophagus, and the digestive gland.

The pharynx is a large, 3-sided, muscular hollow organ that can be extended and contracted when feeding. It is flexible enough and able to open quite widely to engulf seemingly large prey (such as *Haminoea virescens*). Running from the posterior to the anterior of all 3 sides of the pharynx and arising from the dorso-posterior portion of that organ, is the pharyngeal musculature, composed of several flattened, ribbon-like muscles. These are the important agents used in the extension and contraction of the pharynx while engulfing prey. The pharyngeal surface is composed of many striae running perpendicular to a postero-anterior line; it is ivory white in color.

The salivary or pharyngeal glands originate from both sides of the dorso-posterior portion of the pharynx just above the pharyngo-esophageal connection. These glands are thread-like, elongated structures that extend back over the top of the esophagus.

The animal's esophagus is a sac-like enlargement of the digestive tract, located between the pharynx and the digestive gland. The esophagus is flexible enough to be slightly stretched when the pharynx is extended. However, 2 shortened esophageal muscles are attached at one end to the interior walls of the body and at the other end to the right and left sides of the esophagus. This prevents the esophagus from being overly disturbed during pharyngeal extension. The organ is brownish in color, as seen in the holotype.

The digestive gland is the most massive and conspicuous organ in the body and surrounds the reflexed stomach and intestine. This gland is grayish in color and is attached to the esophagus at its ventro-anterior region. It is covered by the posterior or visceral shield and helps give the animal its rather bulky appearance. Below the posterior shield and covering the digestive gland and main reproductive organs is a thin, white, membranous sheath of connective tissue that is somewhat opaque in nature. This membrane envelops the entire posterior viscera, and separation of it from various organs can make dissection a very tedious task.

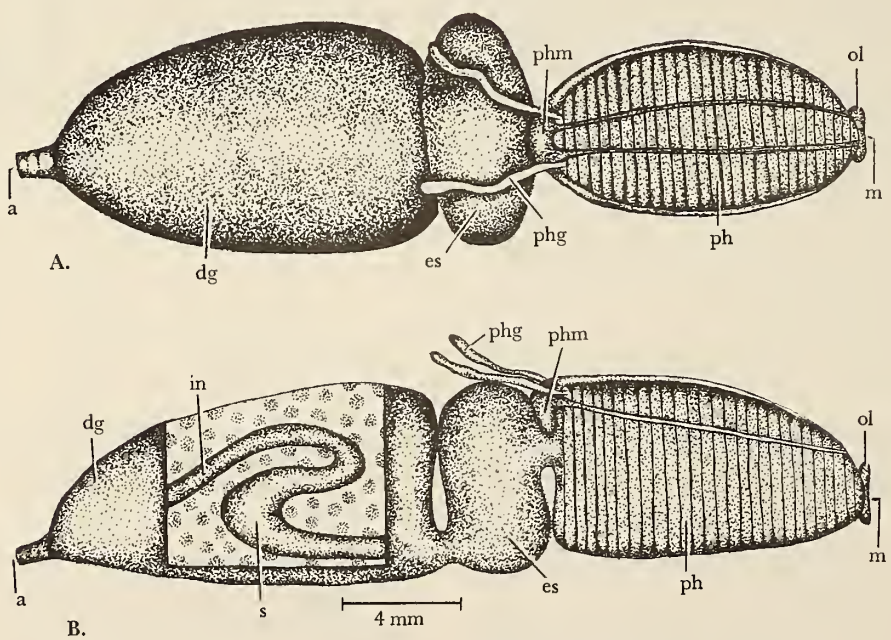


Figure 3

Digesive system

A. Dorsal view; B. Lateral view with section of digestive gland removed to show general position of stomach and intestine
a – anus; dg – digestive gland; es – esophagus; in – intestine; m – mouth; ol – oral lip; ph – pharynx; phg – pharyngeal gland (salivary gland); phm – pharyngeal musculature; s – stomach

Respiratory Apparatus: The gill is a tripinnate external organ, representing a true ctenidium and has its origin in the mantle cavity on the right posterior part of the body between the internal region of the right parapodium and the visceral shield. When extended, the gill may be seen when one observes the animal from above. Most of the time, however, the structure is concealed beneath the visceral shield. The gill measures 8 mm in length in the holotype and is a dull yellowish in color. It is composed of 10 to 12 pairs of lateral branches arising from the main stem. The side branches are further subdivided into 4 or 5 pairs of smaller segments per branch. The main stem is a thickened, flexible and tubular structure and has a slight clockwise curvature to it when the animal is viewed from above.

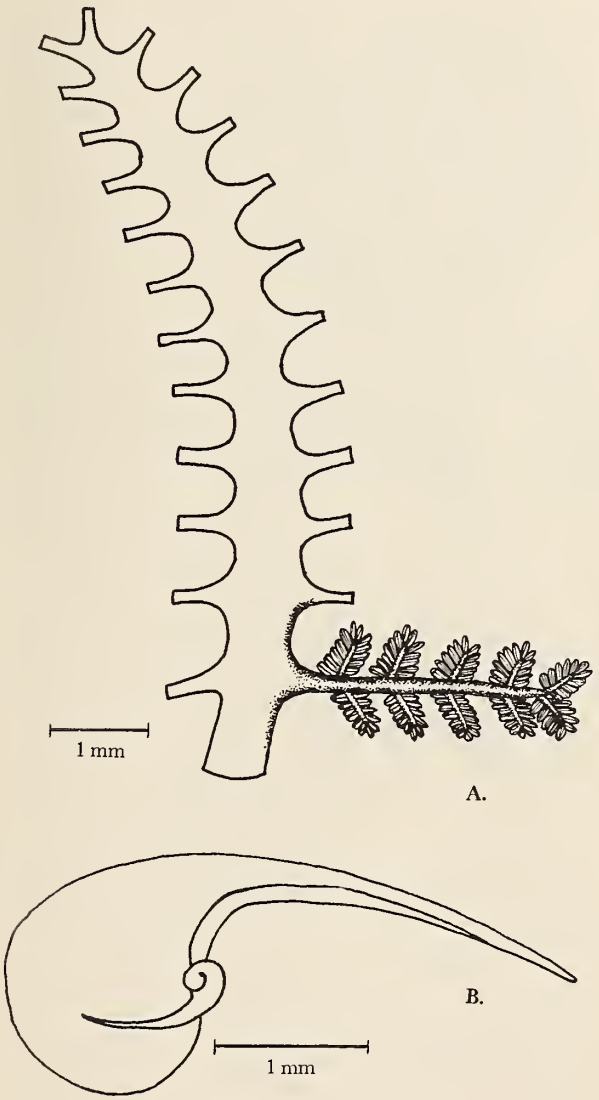


Figure 4

A. Diagram of gill with lateral branch shown in detail, ventral view
B. Diagram of dorsal view of shell

Reproductive System: The reproductive system is extremely compact, small enough to be rather inconspicuous, and hidden by the massive digestive system. The male copulatory apparatus is separated from the rest of the reproductive system and is connected to it only by the narrow seminal groove. The entire system is located exclusively on the right side of the body and involves a great deal of connective tissue.

The gonopore is located on the right side of the body very near the gill origin. It enters the common atrium, includes the vagina and into which opens the duct leading to the bursa copulatrix. This bursa is a disk-shaped organ usually located on the right upper part of the digestive gland. The albumen gland (or possibly membrane gland) arises from the common atrium and leads into the gonoduct. The mucous gland coils clockwise off from the albumen gland and common atrium. The receptaculum seminis is a small, club-shaped projection that leads directly into the gonoduct (very close to the coelomic gonoduct). The narrow post-ampullar coelomic gonoduct coils tightly, then leads to the enlarged, coiled ampulla and via the pre-ampullar coelomic gonoduct to the gonad. The latter is an enlarged, somewhat flattened spheroid-shaped organ located directly to the right and underneath the digestive gland. It is yellowish in color and has a rather bumpy surface texture.

The male copulatory apparatus is located very near the mouth in the anterior portion of the body. The penis, when contracted, is bulbous in shape and located directly beneath the pharynx. It is smooth and unarmed throughout. No spines or papillae are present either externally or internally. From the dark, muscular penial sheath extends a proportionally large, club-shaped prostate that is positioned to the right of the pharynx and is quite conspicuous when the cephalic shield is removed. The seminal groove is a narrow, ciliated depressed line in the interior wall of the animal, leading from the penial aperture to the gonopore.

Nervous System: The anatomically very complex nervous system of *Chelidonura polyalphos* involves 11 ganglia, including 4 paired ganglia. The cerebral ganglia, the largest and most concentrated nervous region in the animal, is composed of right and left ganglia and located on the dorso-anterior surface of the contracted pharynx. The

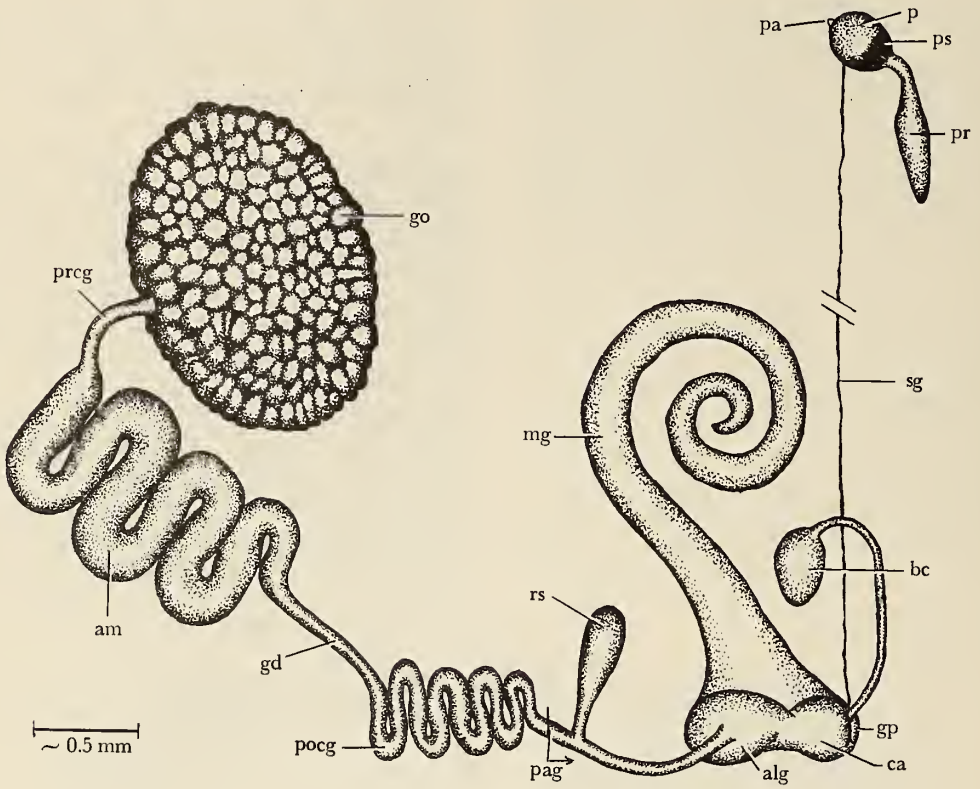


Figure 5

Reproductive system
dorsal view of a slightly teased dissection, (not drawn to scale) alg – albumen gland (possibly membrane gland); am – ampulla; bc – bursa copulatrix; ca – common atrium; gd – gonoduct; go – gonad; gp – gonopore; mg – mucous gland; p – penis; pa – penial aperture; pag – pallial gonoduct; pocg – post ampullar coelomic gonoduct; pr – prostate; prcg – pre ampullar coelomic gonoduct; ps – penial sheath; rs – receptaculum seminis; sg – seminal groove

(adjacent column →)

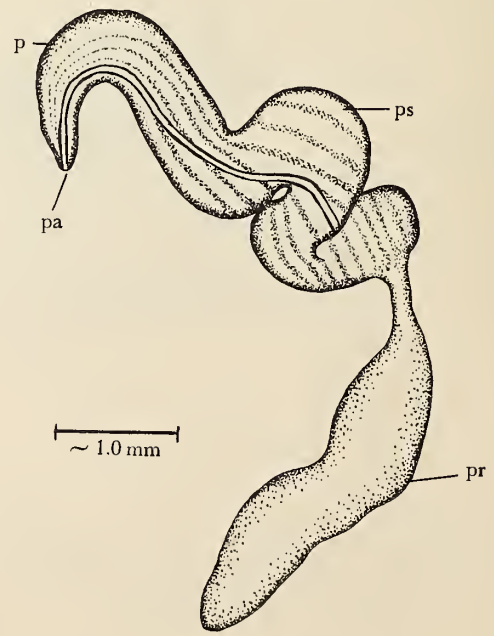


Figure 6

Dorsal view of male copulatory apparatus (penis shown partially extended)
p – penis; pa – penial aperture; pr – prostate; ps —penial sheath

cerebral commissure, a thickened bridge located just below the eyes under the cephalic shield, extends across the pharynx and connects the right and left ganglia of the

cerebral ganglia. Very close to the cerebral commissure and arising anteriorly from the cerebral ganglia are the paired labial, optic, and cerebral nerves. The labial nerves are composed of small nervous networks, establishing connections with the oral lip and general labial region. The optic nerve is a very thin, somewhat transparent connection between the left and right eyes and respective cerebral ganglia. The cerebral nerves form a very large and extensive continuation of the cerebral ganglia, extending forward, branching extensively, and forming various connections with the cephalic lobes and general cephalic region. Posterior to the cerebral ganglia and slightly laterally to them are the pedal ganglia. These are connected anteriorly to the cerebral ganglia and posteriorly by the pedal commissure, which is greatly elongated and extends posteriorly to circuit around the posterior end of the pharynx. From the pedal ganglia arise several sets of pedal nerves which branch at the ends, forming nerve nets and part of the somatic nerve makeup. The pleural ganglia arise at the posterior of the cerebral ganglia and lie adjacent to the pedal ganglia. The pleuro-pedal connective is quite small and can be seen only when the ganglia are separated during dissection. To the right of the right pleural ganglion is the parietal ganglion, from which arise 2 elongated nerves (labeled nerve 2 and 3 [n^2 and n^3] in Figure 7). The visceral loop connects the 2 posterior ganglia with the cerebral ganglia (via the pleural ganglia). Also arising from the cerebral ganglia is the subcerebral commissure which circuits the ventral portion of the pharynx and is elongated, allowing passage of the pharynx during extension and contraction while feeding, and the cerebro-buccal connective which extends along the sides of the pharynx and connects the buccal to the cerebral ganglia. The buccal ganglia are located just below the pharyngo-esophageal connection on the pharynx. Arising from the buccal ganglia are the pharyngeal and esophageal nerves.

The subintestinal ganglion and a fusion between the genital and abdominal ganglia are connected at the very posterior-most of the system. The genito-abdominal ganglion is considerably larger than the subintestinal ganglion and the conspicuous genital nerve arises from it and extends to the reproductive system. On the left portion of the visceral loop, which connects the cerebral and posterior ganglia, arises a short, unbranched nerve (nerve 1). This nerve, as well as nerve 2, extends into the visceral region. Nerve 3 points to the right exterior part of the body. The exact identification of these 3 nerves is very difficult and information concerning them in the literature is sketchy. For these reasons, their identification will not be attempted here.

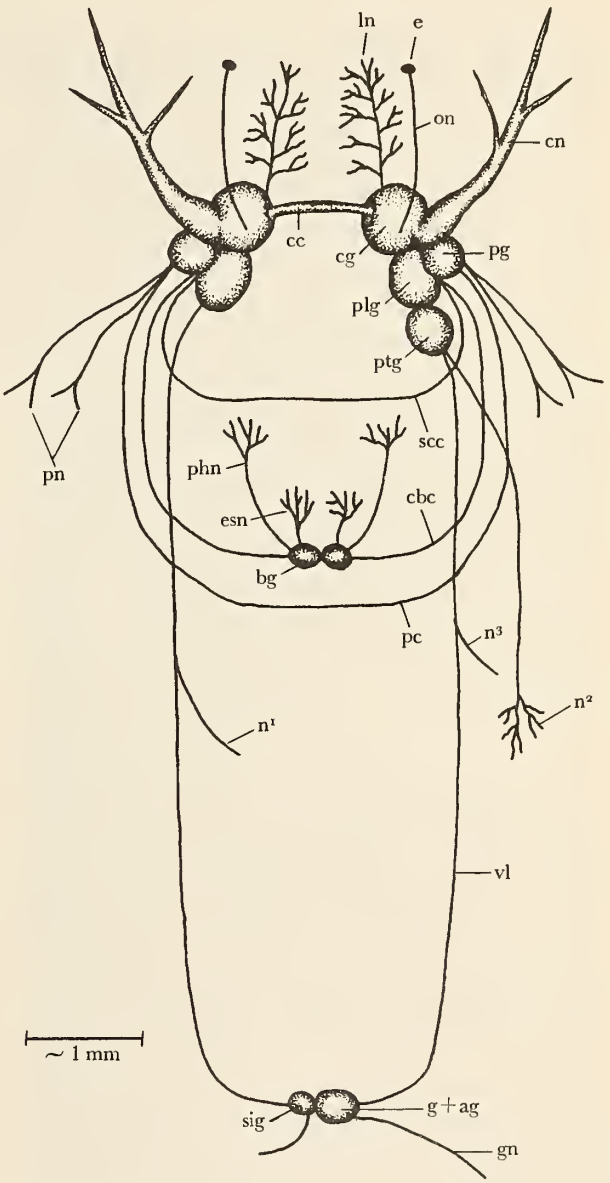


Figure 7

Dorsal view of nervous system (not drawn to scale)
bg – buccal ganglion; cbc – cerebrobuccal connective; cc – cerebral commissure; cg – cerebral ganglion; cn – cerebral nerves; e – eye; esn – esophageal nerves; g+ag – genital plus abdominal ganglia; gn – genital nerve; ln – labial nerves; n^1 – nerve 1; n^2 – nerve 2; n^3 – nerve 3; on – optic nerve; pc – pedal commissure; pg – pedal ganglion; phn – pharyngeal nerve; plg – pleural ganglion; pn – pedal nerves; ptg – parietal ganglion; scc – subcerebral commissure; sig – subintestinal ganglion; vl – visceral loop

DISCUSSION

Ecological Relationships: In the intertidal mudflat pools of San Carlos Bay, two species of *Chelidonura* seemingly co-exist within the confines of this subtropical ecosystem. Since both *C. polyalphos* and *C. inermis* prey on the same species, *Haminoea virescens,* and live under identical abiotic conditions, it would seem that the two species occupy the same niche. By the principle of competitive exclusion expressed by Gause and others in the 1930's, complete competitors cannot co-exist. That is, complete competitors cannot co-exist permanently in the same niche. Two species must differ in niche requirements in certain features that can reduce competition between them. In the case of the two species of *Chelidonura, C. inermis* has gone beyond being *Haminoea*-dependent for food and differs in feeding habits from *C. polyalphos* in the variety of diet. A dissection of the gut of a 63 mm long specimen of *C. inermis* revealed a rather large shell of *Bulla gouldiana* Pilsbry, 1895, in the midgut. Bertsch (1970: 172) documents similar feeding habits of *C. inermis* from the Gulf of California. Since *C. inermis* is large enough (over 50 mm) to be able to prey on *Bulla* as well as on *Haminoea,* this shows a significant difference between the two species. *Bulla* is not a common animal of the winter mud flats, but is an established member of that mud flat faunal community. Theoretically, by Gause's principle, if both *C. inermis* and *C. polyalphos* did occupy the same niche in the same stabilized community within the same geographical area, then one would eventually give way to the other until that one disappeared completely. This does not seem to be the case in San Carlos Bay since, as far as our observations have been able to determine, the two species can effectively co-exist and the principle of competitive exclusion is upheld. The fact that the two species have different geographical ranges, however, implies that they also have different physical tolerances. This may explain why the two populations are so numerically dissimilar, *i. e.,* on December 24, 1970, only two individuals of *C. inermis* were observed, while over a dozen individuals of *C. polyalphos* were seen.

Since the nutritional requirements of *Chelidonura inermis* and *C. polyalphos* are similar, they are probably competitive species, but since their requirements are not exactly alike, severe or direct competition is not a problem. The generalization that closely related species cannot co-exist, is not upheld in this case, since *C. inermis* and *C. polyalphos* are closely related species. Their relationship on the San Carlos mudflats, as viewed at present, is one of co-existence. Intraspecific predation (cannibalism) and interspecific predation are quite possible, but no observations have been carried out in this respect at the present time.

External Characteristics: As far as general body shape is concerned, *Chelidonura evelinae, C. inermis,* and *C. polyalphos* have almost precisely the same structure. Color patterns do differ, however. *Chelidonura evelinae* is dark brown with whitish spots; there are longitudinal yellow stripes on the dorsal surface that "dilate to spots powdered with white. A row of metallic blue spots bordered with black accompanies the margins of parapodia, the spots increase with age." (Marcus, 1955: 95 - 96).

In the case of *Chelidonura inermis,* the ground color can vary from ochre to brown, almost black. Yellow longitudinal lines may or may not be present on the dorsal surface. White and blue spots may be observed on the dorsal surface of the parapodia in some specimens.

Chelidonura polyalphos is a dark brown with white spots which become concentrated in certain regions of the dorsal surface. No yellow or blue pigmentations are found on any portion of the animal.

Shell Characteristics: The shells of *Chelidonura inermis* are very characteristic; all shells removed from this species possessed a large, cellophane-like wing attached to the normal calcified shell. The calcified portion of the shell seems highly variable, but appears to become elongated with age, while the height remains fairly constant.

In *Chelidonura evelinae* the shell is highly variable in shape and has no transparent extension. The shell seems not to arise from a symmetrical spiralling whorl, as is the case with *C. inermis* and *C. polyalphos.*

In *Chelidonura polyalphos* the shell has a much greater regularity of form. It appears that in this species the length to height ratio of the shell remains fairly constant or decreases slightly with age, but not enough shell specimens were observed to pronounce this a well established fact.

Nervous System: Very little work has been published on cephalaspidean nervous systems, but what has been published has been very informative. Guiart (1901) provides a very well illustrated text, particularly regarding species of *Philine, Acteon,* and *Haminoea.* Hoffmann (1936) also provides excellent detail of nervous systems in cephalaspideans as well as in other groups of opisthobranchs. Bullock & Horridge (1965) also delve into opisthobranch nervous systems, but provide no great detail on cephalaspideans.

The nervous system in the family Aglajidae seems to be comparatively consistent anatomically. In *Chelidonura polyalphos,* several changes have occurred which distinguish it from the hypothetical ancestral opisthobranch

Table 1

Shell Measurements

Species:	*polyalphos*			*Chelidonura inermis*							*evelinae*
Portion of shell measured	total shell			clear wing		calcified portion					total shell
Specimen	1	2	3	1	2	1	2	3	4		1
Shell length (mm)	3.5	3.6	3.5	12.6	6.0	4.8	3.4	2.3	3.0		5
Shell height (mm)	1.6	1.8	1.8	7.4	4.3	1.3	1.5	1.0	1.3		5
Length:height (ratio)	2.2	2.0	1.9	1.7	1.4	3.7	2.3	2.3	2.3		1

first postulated by GUIART in 1901. In *C. **polyalphos,*** the parietal ganglion has migrated to the right and has come in tack with the posterior part of the right pleural ganglion. Also, the abdominal and genital ganglia have migrated together and fused. This fusion has migrated with the subintestinal ganglion to the point where the two are in contact with each other at the very posterior end of the nervous system.

HOFFMANN (1936) describes a nerve in *Haminoea* similar to nerve 3 in *Chelidonura **polyalphos*** and refers to it as the osphradial nerve with a question mark. Because of this dubious reference, the nerve will not be named here. Neither will we name nerves 1 and 2 for similar reasons.

The cerebral commissure in *Chelidonura inermis* is relatively thickened and has a length to width ratio of 6 : 1, while the rather elongated commissure of *C. **polyalphos*** has a length to width ratio of 8 : 1. The ratio of cerebral commissure length to cerebral ganglion lobe diameter varies in all 3 similar *Chelidonura* species. The ratio in *C. inermis* is 3 - 2 while in *C. **polyalphos*** it is over 2 : 1. MARCUS (1955) describes *C. evelinae* as having a cerebral commissure shorter in length than the diameter of a single cerebral ganglion lobe.

Digestive System: The digestive system of *Chelidonura evelinae* is easily distinguished from those of *C. inermis* and *C. **polyalphos*** by its diverticulated esophagus and short, rounded salivary glands. Both *C. inermis* and *C. **polyalphos*** have proportionally longer salivary glands and an esophagus without diverticula.

The differences between *Chelidonura inermis* and *C. **polyalphos*** will be examined in greater detail. The buccal ganglion in *C. inermis* is located approximately 10 mm below the pharyngo-esophageal juncture, while in *C. **polyalphos*** of the same size the ganglia are adjacent to the juncture.

The relative size of the pharynx to the rest of the body is much greater in *C. inermis.* The pharynx of this species tapers at the end and gradually gives way to the esophagus. The existence of a definite junction between the pharynx and the esophagus is therefore uncertain. In *C. **polyalphos,*** the pharynx ends abruptly and the pharyngo-esophageal juncture is quite evident. The esophagus in *C. inermis* is greatly elongated and reflexed along the right side of the digestive gland to which it is attached at the postero-ventral portion of the gland. In *C. **polyalphos*** the esophagus is not elongated and is attached to the anterior portion of the digestive gland along the midline.

The salivary glands in *Chelidonura inermis* are flattened and ribbon-like in shape, and are located at the dorsal portion of the esophageal-pharyngeal juncture. The right gland extends anteriorly along the right side of the pharynx while the left gland extends anteriorly along the ventral side of the pharynx. In *C. **polyalphos*** the glands are proportionately longer than in *C. inermis* and are thin, thread-like structures located several millimeters above the pharyngo-esophageal juncture. The glands are symmetrical and extend posteriorly behind the pharynx.

Reproductive System: The reproductive system of *Chelidonura **polyalphos*** differs from that of the similar *C. evelinae* in a significant manner. The position of the duct leading from the receptaculum seminis to the rest of the reproductive system differs in both species. It arises in *C. evelinae* directly from the albumen gland while in *C. **polyalphos*** it arises from the gonoduct between the coelomic gonoduct and the albumen (or membrane) gland.

In *Chelidonura inermis,* the bursa copulatrix is quite large and conspicuous in relation to the rest of the reproductive system. It is considerably smaller in relation to the rest of the reproductive system in *C. **polyalphos,*** and it is also rather inconspicuous.

Synonymy of *Chelidonura inermis* (Cooper, 1862) and *Aglaja bakeri* MacFarland, 1924

Aglaja bakeri is known only from the holotype collected by Dr. Fred Baker on May 12, 1921 at San Marcos Island, Gulf of California. The specimen, in the California Academy of Sciences (CAGTC 1736), contains well developed cephalic lobes characteristic of the genus *Chelidonura*, rather than the simple rounded head characteristic of the genus *Aglaja*. The specimen in question contains a well developed shell with an elongated rib which is applicable to the genus *Chelidonura*, rather than the more simply rounded shell with a shortened rib found in the genus *Aglaja*. On this basis *A. bakeri* should be transferred to *Chelidonura*.

The body color of the specimen is described as "dark brown everywhere, marked with narrow irregular longitudinal lines of yellowish white on the cephalic and body shields and on the outer faces of the parapodia. Near the parapodial margin on their outer base is a row of ocelli, composed of light blue, rounded or elliptical, each edged with a narrow band of black, the largest c. .5 mm. in length" (MacFarland, 1924: 391 - 392). In his analysis of *Chelidonura inermis* MacFarland (1966) states that the color of the body ranges from van dyke brown to ochre and mentions longitudinal, light yellow lines, yet makes no mention of bluish spots. However, on plate 2, figures 1 - 3, the same bluish spots on the parapodial margins described in *Aglaja bakeri* are illustrated.

MacFarland (1924: 395) describes the shell of *Aglaja bakeri* as consisting "of a narrow calcified portion, expanded in front and at the left into a large, thin, membranous extension." The general color of the calcified portion is a light yellow, deepening somewhat in thicker portions. Although MacFarland makes no mention of the shell of *Chelidonura inermis* in his 1966 analysis of that species, the authors as well as Mr. Richard Roller of San

(← adjacent column)

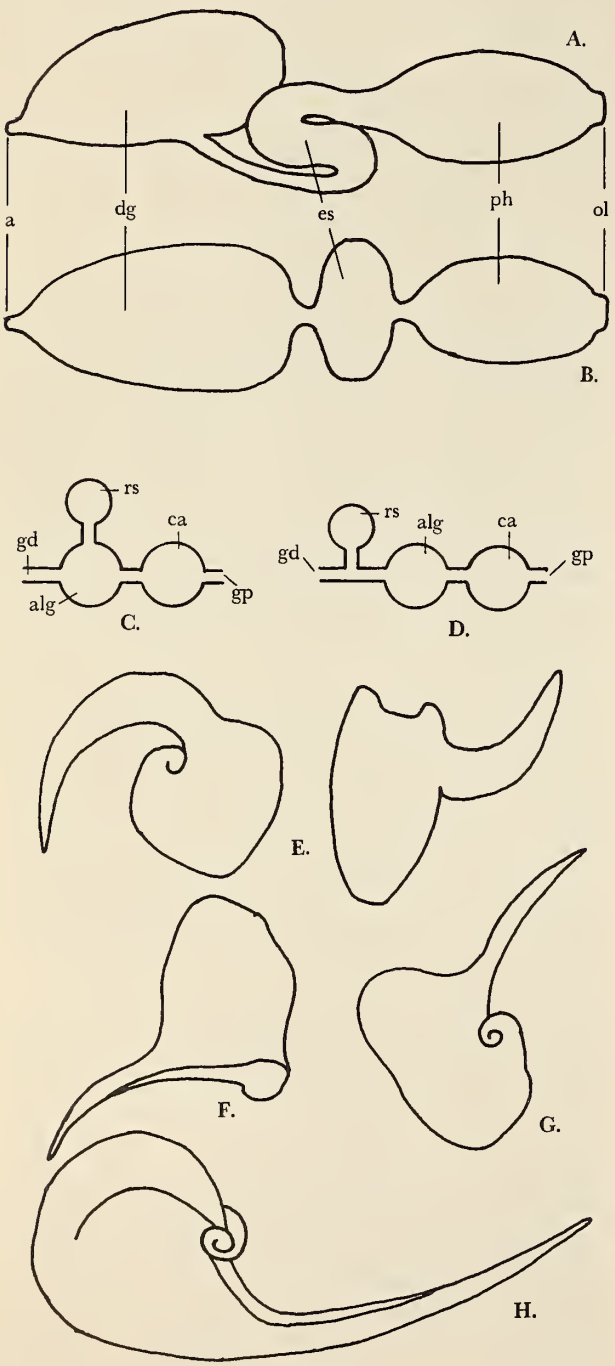


Figure 8

Diagrams in comparative anatomy

A. Digestive system of *Chelidonura inermis*; B. digestive system of *Chelidonura polyalphos*. C. Portion of reproductive system of *Chelidonura evelinae*; D. portion of reproductive system of *Chelidonura polyalphos*. E. Shell of *Chelidonura evelinae* (after Marcus, 1955); F. shell of *Chelidonura inermis*; G. shell of *Aglaja bakeri*; H. shell of *Chelidonura polyalphos* (ventral view)
a – anus; alg – albumen gland (possibly membrane gland); ca – common atrium; dg – digestive gland; es – esophagus; gd – gonoduct; gp – gonopore; ol – oral lip; ph – pharynx; rs – receptaculum seminis

Luis Obispo, California, have removed shells of specimens from throughout the Gulf of California and California coasts, and have found them to be identical with that described by MacFarland for *A. bakeri* and shown in plate 11, figures 16 - 17 of that description.

Examination of the specimen of *Aglaja bakeri* by the authors revealed no contradiction with the description by MacFarland. Based on the above data it must be concluded that there is no significant basis on which *A. bakeri* can be regarded as a distinct species and must, therefore, be considered a junior synonym of *Chelidonura inermis* (Cooper, 1862).

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Literature Cited

Allan, Joyce K.
1933. Opisthobranchs from Australia. Rec. Austral. Mus. Sydney, 18 (9): 443 - 450; pl. 56

Angas, George French
1867. Descriptions of thirty-two species of marine shells from the coast of New South Wales. Proc. Zool. Soc. London

Baba, Kikutarô
1938. Opisthobranchs of Kii, Middle Japan. Journ. Dept. Agric. Kyushu Imp. Univ. 6 (1): 1 - 19

1949. Opisthobranchia of Sagami Bay, collected by his Majesty the Emperor of Japan. Tokyo. 104 pp.; 50 plts.; 7 text figs. Biol. Lab. 8 (1):79 - 85; plts. 7, 8 (November 1949)

Baba, Kikutarô & T. Abe
1959. The genus *Chelidonura* and a new species *C. tsurgensis* from Japan. Publ. Seto Mar. Biol. Lab. 7: 279 - 290

Bergh, Ludwig Sophus Rudolf
1900. Malakologische Untersuchungen in Semper's Reisen im Archipel der Philippinen. Vol. 4 (2), Lief. 1: 159 to 208

1902. Malakologische Untersuchungen in Semper's Reisen im Archipel der Philippinen. Vol. 7, Abt. 4, Abs. 4: 313 - 382; plts. 25 - 29.

1905. Die Opisthobranchiata der Siboga Expedition. Siboga Exped. prt. 50: 1 - 248; plts. 1 - 20

Bertsch, Hans & Alberic Smith
1970. Observations on opisthobranchs of the Gulf of California. The Veliger 13 (2): 171 - 174 (1 October 1970)

Billings, W. D.
1970. Plants, man, and the ecosystem. Wadsworth Publ. Co., Inc., Belmont, Calif. 160 pp.

Bullock, Theodore Holmes & G. Adrian Horridge
1965. Structure and function in the nervous system of invertebrates. W. H. Freeman and Co., San Francisco & London, 2 vols.

Burn, Robert
1966. Some opisthobranchs from southern Queensland. Journ. Malac. Soc. Austral. 1 (9): 96 - 109

Edmunds, Malcolm
1968. Opisthobranch Mollusca from Ghana. Proc. Malac. Soc. London 38: 83 - 100

Eliot, Charles N. E.
1903. On some nudibranchs from East Africa and Zanzibar. Proc. Zool. Soc. London 1903 (II): 250 - 257 (Aug. 1903)

Gause, G. F.
1934. The struggle for existence. (Repr. 1964) Hafner, New York, 163 pp.

Ghiselin, Michael Tenant
1966. Reproductive function and the phylogeny of opisthobranch gastropods. Malacologia 3 (3): 327 - 378; 7 text figs. (31 May 1966)

Guiart, Jules
1900. Les mollusques tectibranches. Causeries scientifiques. Soc. Zool. France 1: 79 - 132; 4 plts.

1901. Contribution à l'étude des gastéropodes opisthobranches et en particulier des céphalaspides. Mém. Soc. Zool. France Paris 14: 1 - 219; plts. 1 - 7; 119 text figs.

Hoffmann, Hans
1932- 1940. Opisthobranchia. *In*: Bronn's Klassen und Ordnungen des Tierreichs 3 (2; 3; 1, 2): 1377 pp.

Hyman, Libbie Henrietta
1967. The invertebrates. McGraw Hill Inc. 6: vii + 792 pp.; 249 text figs.

MacFarland, Frank Mace
1924. Expedition of the California Academy of Sciences to the Gulf of California in 1921. Opisthobranchiate Mollusca. Proc. Calif. Acad. Sci. 13 (25): 389 - 420; plts. 10 - 12

1966. Studies on opisthobranchiate mollusks of the Pacific Coast of North America. Mem. Calif. Acad. Sci. 6: vxi + 546 pp.; 72 plts. (8 April 1966)

Marcus, Ernst
1955. Opisthobranchia from Brazil. Bol. Fac. Fil. Ci. Letr. Univ. S. Paulo, Zool. 20 (2): 89 - 262; plts. 1 - 30
1961. Opisthobranch mollusks from California. The Veliger 3 (Suppl.) (I): 1 - 84; plts. 1 - 10 (1 February 1961)
Marcus, Eveline DuBois Raymond & Ernst Marcus
1967. American opisthobranch mollusks. Stud. Trop. Oceanogr. Miami 6: viii + 256 pp.
1970. Some gastropods from Madagascar and West Mexico. Malacologia 10 (1): 181 - 223
Pruvot-Fol, Alice
1953. Étude de quelques opisthobranches de la côte Atlantique du Maroc et du Sénégal. Trav. Inst. Chérif. Zool. 5: 1 - 105; plts. 1 - 3; 35 text figs.
Quoy, Jean René Constant, & Joseph Paul Gaimard
1833. Voyage de découvertes de l'Astrolabe exécuté par ordre du Roi, pendant les années 1826 - 1829, sous le commandement de M. J. Dumont d'Urville. Zoologie, Mollusca 2: 321 - 686
Risbec, Jean
1928. Mollusques nudibranches de la Nouvelle Calédonie. Faune de l'Union Française, fasc. 15: 1 - 126
Smith, Robert Leo
1966. Ecology and field biology. Harper & Row, New York, 686 pp.
Swennen, Charles
1961. On a collection of Opisthobranchia from Turkey. Zool. Meded. 38 (3): 18 text figs.
Taylor, L. R., Jr.
1970. Untaxing taxonomy. Oceans 3 (6): 106
Whittaker, Robert H.
1970. Communities and ecosystems. Macmillan Co., London, 161 pp.